

Laude's CH301 Worksheet 2 answer key (Sections 1.10-1.21)
 (The textbook referenced is Atkins & Jones's *Chemical Principle*, 3rd edition)

Part I.

1. Mix and match. Connect the number with the statement about quantum numbers. Look at every word carefully!!

- Number of orbitals for $n = 3$? 9
 Maximum number of electrons for $n = 2$ 8
 Number of orbitals when $n = 3$ and $l = 0$ 1
 Maximum number of electrons in the $n = 5$, $l = 2$ orbitals 10
 Maximum number of electrons in a $n = 5$, $l = 3$ orbital 14
 Maximum number of electrons when $n = 2$, $l = 2$ there is no such orbital, 0

2. Assume the electronic configurations below are for ground state atoms. Note that the electronic configurations are **incorrect** in each case. What is the atom and what principle(s) does it violate?

$\overline{1s} \quad \overline{2s} \quad \overline{\quad} \quad \overline{\quad} \quad \overline{\quad}$ atom Oxygen violated principle Hund's rule

$\overline{1s} \quad \overline{2s} \quad \overline{\quad} \quad \overline{\quad} \quad \overline{\quad}$ atom Sodium violated principle Pauli exclusion principle

$\overline{1s} \quad \overline{2s} \quad \overline{\quad} \quad \overline{\quad} \quad \overline{\quad}$ atom Neon violated principle Pauli exclusion principle

$\overline{1s} \quad \overline{2s} \quad \overline{\quad} \quad \overline{\quad} \quad \overline{\quad}$ atom Flourine violated principle Aufbau

3. Write the ground state and the lowest excited electronic configuration for the following elements: (feel free to work similar problems in the text: 1.65-1.70, pg 49-60.)

atom	P	N	K
ground	$1s^2 2s^2 2p^6 3s^2 3p^3$	$1s^2 2s^2 2p^3$	$1s^2 2s^2 2p^6 3s^2 3p^6 4s^1$
lowest excited	$1s^2 2s^2 2p^6 3s^1 3p^3 3d^1$	No excited state *	$1s^2 2s^2 2p^6 3s^2 3p^6 4p^1$

(*) You need an empty orbital to excite your electron up to. In this case, there is no 2d orbital, thus, no excited state.

4. What is the valence shell electron configurations of these elements: (feel free to work similar problems on the text: 1.71-1.76)

S $3s^2 3p^4$

Fe⁺⁺ $3d^4 4s^2$

Ti⁺⁺ $4s^2$

O⁻ $2s^2 2p^6$

Cu $3d^9 4s^2$

He⁺⁺ no electron, no configuration

5. Calculate the effective nuclear charge (a whole number) for the following atoms or ions?

He⁺ +2

Li⁻ +1

O +6

S⁺⁺ +4

6. For the following pairs of atom or ions, fill in the blank with either < or > to correctly order the identified periodic trend.

Atomic radius Si > Cl Br < I Au < Hf Mg < Cd
 Ionization Potential Na < K He < H N < O Al > Mg
 Ionic Radius K⁺ < Cs⁺ F⁻ > Ne Ar > K⁺ Al⁺³ < N⁻³
 Electron Affinity Cl > I O < F Na > Mg H > He

Part II. Thought questions for the thoughtful—show that you really know your stuff by creating the periodic table for an entire new set of quantum rules.

1. Suppose someday you are able to come through a black hole to a different world, in which the atoms are built up in a slightly different fashion from our good ol' universe. In the new universe there are three electrons in each orbital and there are only 2 sub levels x and y, each with 2 orbitals. Construct the periodic table through n = 3 in the table below. For example, if you did it correctly, your “Fe” will have a configuration of 1x⁶ 1y⁶ 2x⁶ 2y⁶ 3x².

Fill in elements H through Kr below

n = 1	H	He	Li	Be	B	C	N	O	F	Ne	Na	Mg
n = 2	Al	Si	P	S	Cl	Ar	K	Ca	Sc	Ti	V	Cr
n = 3	Mn	Fe	Co	Ni	Cu	Zn	Ga	Ge	As	Se	Br	Kr

2. Read section 1.13 to understand how elements are placed where they are in the periodic table. Which elements in this new world do you expect to share the same chemical reactivity with “Fe”(read section 1.20 for this)? Would your element be considered more “metallic” or more “nonmetallic”? What elements would be least reactive? What are some likely salts that might form?

Elements sharing Fe’s reactivity He, Si Metallic or nonmetallic? Metallic

Least reactive elements? Mg, Cr, Kr Some likely salts HNa, SiV₂, BCa

3. Read sections 1.15, 1.16 and 1.17 to understand the trend in ionic radius, ionization energy as well as electron affinity as atomic number increases/decreases. Apply the fundamental principles to your own periodic table. Now, compare the element “Na” and “S” to see which one has the larger radius, ionization energy and electron affinity. Fill in the blank with the appropriate < or > symbol.

Atomic radius Ionization energy Electron affinity
 Na < S Na > S Na > S

4. Calculate the effective nuclear charge of “Fe” in your new world. (Re-read section 1.11 if needed)
 Effective nuclear charge: 2